Distribution of Coronavirus Disease (Covid-19) in West Sumatra Province with Local Indicator of Spatial Association (LISA) Cluster Map

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Abstract

The COVID-19 pandemic in West Sumatra Province indicates a greater number of cases and mortality. The spread of COVID-19 is related to the mobility of the population, so the potential for transmission between regions is difficult to control. This study aims to determine the local index used in evaluating the tendency for local spatial groupings and can show some form of spatial relationship. Spatial analysis were conducted on 2020 to analyze spatial distribution of Covid-19 in West Sumatera Province. Spatial relationship was assessed by Local Indicator of Spatial Association (LISA). Mapping can be done with the LISA cluster map. The data used is COVID-19 incidence data based on reports from district or city in West Sumatra Province in 4 June 2020. We used Open Geoda Software to analyze the spatial distribution. There is positive spatial autocorrelation and classification in hot spots, cold spots, and outliers in the spread of COVID-19 cases in West Sumatra Province. Hot spots were found in Padang City, Bukittinggi City, and Padang Panjang City. Cold spots also detected in several districts, that is West Pasaman, Pasaman, Payakumbuh, Solok, Padang Pariaman, Pariaman, Sawahlunto, and Sijunjung. The transmission of the COVID-19 case does not recognize regional boundaries, but the grouping of districts or cities based on regional vulnerability is important as part of local control efforts to allocate resources. Coordination and collaboration among local governments need to be strengthened in preventing transmission between regions and reducing the number of cases in vulnerable areas based on hot spots and cold spots from LISA cluster map. It's necessary for intervention programs more focused and effectively.

Keywords: COVID-19, Mapping, Spatial, Vulnerability

INTRODUCTION

Beginning in 2020, the globe was horrified by the emergence of a novel coronavirus (SARS-CoV-2) that caused the Coronavirus illness 2019 pandemic (COVID-19). It is known that this virus originated in Wuhan, China (Taufik et al., 2022). Coronavirus Disease 2019 (COVID-19) is caused by a new type of coronavirus. The new type of virus is known as Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). COVID-19 cases have a high risk of transmission and can lead to severe infection, organ failure, and ultimately death. The significant increase in the number of cases and its widespread in various countries caused the World Health Organization (WHO) on 30 January 2020 to declare COVID-19 a case of Public Health Emergency of International Concern (PHEIC). Along with the increasing

number of cases and the increasing number of deaths due to COVID-19, on 11 March 2020, WHO declared COVID-19 a pandemic (Kemenkes RI, 2020; WHO, 2020a; WHO, 2020b).

COVID-19 was first detected in Indonesia on 2 March 2020, and by 31 March 2020 there had been 1,528 confirmed COVID-19 cases with 136 deaths. The coronavirus-19 (Covid-19) outbreak caused by SARS-CoV-2 has spread much faster than previously thought. Currently, WHO globally notes that there have been 267,865,289 confirmed cases and 5,285,888 cases of death (Handayani, 2022). Based on this, COVID-19 was designated by the government as a Non-Natural National Disaster on 13 April 2020 (Susilo et al., 2020; Fitri, 2020; Kemenkes RI, 2020). COVID-19 cases in West Sumatra Province were first reported on 26 March 2020 and the number of cases continues to grow and the distribution area is expanding. In the first few months since it was first reported in West Sumatra, COVID-19 cases were mostly found in Padang City, Padang Panjang City, Bukittinggi City, and Pesisir Selatan Regency, and expanded to all districts / cities in West Sumatra Province (Pemerintah Provinsi Sumatera Barat, 2020).

Transmission of COVID-19 through close contact through droplets, direct or indirect contact from person to person, the spread is closely related to population movement/mobility, so that it can affect the number of cases in a particular area, especially if the population of an area has high mobility, either because of travelling for work, school, or tourism. In general, every region has the potential to become an area of transmission of COVID-19 cases, and the situation of an area can be related to the situation in other areas, especially neighbouring or adjacent areas. Especially if it is associated with unlimited population mobility between regions, so that every region has the possibility of becoming a vulnerable area (Soehardi, 2020).

Research conducted by Masbiran (2020) shows a decrease in the number of tourist visits, transportation sector revenues such as public transportation, and warehousing, as well as the provision of accommodation and eating and drinking labor, as well as losses and a decrease in business income, especially in the tourism sector. West Sumatra Province, as one of the tourist destinations that is quite popular with domestic and international tourists, because of its natural beauty, culture, and also culinary, is certainly affected by the high spread of COVID-19 cases. The rapid transmission of COVID-19 cases that can occur in every vulnerable person is certainly a concern because people must have a vigilant attitude and be able to recognize the risk of transmission from others.

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Previous research conducted on the people of Padang City showed that there was a moderate level of transmission risk. In addition, COVID-19 cases also have a greater risk of severity for residents with risk factors such as old age and a history of non-communicable diseases. Data in Padang City shows as many as 65,550 elderly people, 203,787 people with hypertension, and 22,538 people with diabetes mellitus, with 177 positive cases of COVID-19. Padang City, as the provincial capital, has access to entrances through air ports, seaports, and land routes from outside the province, causing the risk of COVID-19 transmission to be quite high due to the potential mobility of residents from inside and outside the region.

The results of Yuniarti et al.'s research showed that the incidence of COVID-19 and the number of populations with the highest comorbidities in West Sumatra were found in Padang City as the epicenter of the spread of cases (Ukhwatul, 2020; Putra, 2022; Yuniarti, 2020). Meanwhile, a study conducted by Rahmi et al. (2020) found that West Sumatra Province is one of the provinces included in cluster 1 of COVID-19 transmission, meaning that these conditions indicate that West Sumatra Province has a high number of COVID-19 cases and inadequate health facilities. Therefore, West Sumatra Province is one of the most vulnerable areas facing the possibility of a wider spread of COVID-19, and with limited health service capacity to deal with COVID-19 cases, it is feared that there will be high morbidity and mortality rates (Rahmi, 2021).

Therefore, an analysis is needed to assess the level of relationship in data influenced by space (spatial data), so that later the level of regional vulnerability to disease transmission will be obtained based on an assessment of the relationship between geographic location and COVID-19 cases. As with infectious diseases in general, COVID-19 does not recognise regional boundaries in its spread, but it is necessary to group disease incidence by region, especially administratively. This will be related to control/intervention programmes that require resources that can only be allocated by administrative governments.

METHODS

This research is a geographic information system-based analytical study using secondary data to assess the spatial relationship between regions and the incidence of COVID-19. We collected and analyzed COVID-19 incidence data from the report of West Sumatra Province Health Office on 4 June 2020 with a total of 583 cases spread in 19 districts and cities. Spatial analysis was conducted using Open Geoda software. The data were analyzed using the Local indicator of spatial association (LISA) to determine the index

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used in evaluating trends or trends in spatial clustering locally and showing various forms of spatial relationships. Hot spot and cold spot area indicated transmission area and potentially expand to another area. Moran's local index (Moran's I) can be used to detect the presence of hotspots and cold spots in an area through a scatterplot graphic depiction spread across a diagram consisting of quadrant I to quadrant IV. Mapping can be done with the LISA cluster map from Open Geoda Software. The map can visualised the hot spots, cold spots, and outliers of spread of transmission in districts and cities based on COVID-19 incidence data.

RESULTS

The Moran scatterplot graph generated from the analysis can be interpreted in 4 quadrants. Quadrants I and III indicate that there is a grouping of the same values (high or low) or have positive spatial autocorrelation, and in quadrants II and IV indicate that there is a grouping of different values or have negative spatial autocorrelation (Adhisuwignjo, 2012).

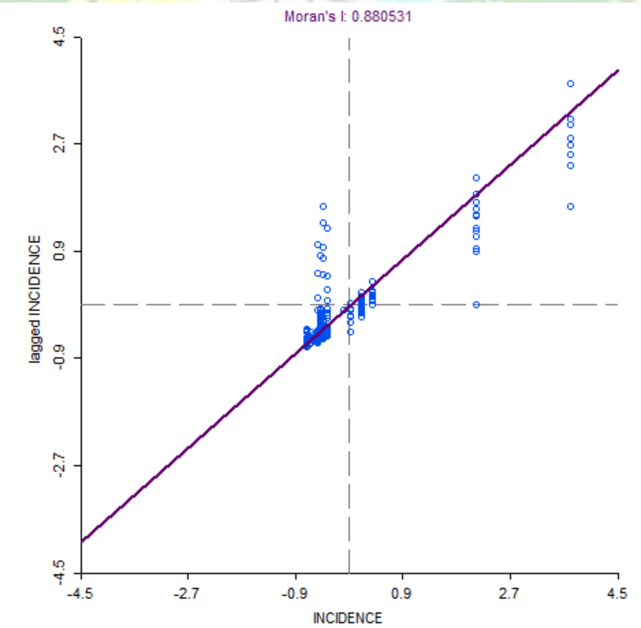


Figure 1. *Scatter Moran's I Graph*

The Moran's I Scatter Graph in figure 1 can be interpreted as follows (Adhisuwignjo, 2012; Banerjee, 2014) :

a) Quadrant I or high-high (H-H) areas, which is an area with a high value with surrounding areas that also have high values. Areas included in quadrant I are on the upper right.
b) Quadrant II or low-high (L-H) areas, which is an area with low value surrounded by areas that have high value. The area included in quadrant II is on the upper left.

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c) Quadrant III or low-low (L-L) areas, which is an area with low value surrounded by areas that also have low value. Areas included in quadrant III are on the lower left.

d) Quadrant IV or high- low (H-L) areas, which is a high value region surrounded by low value regions. Quadrant IV areas are located at the bottom right.

To find out which areas are in each quadrant, it can be seen on the maps presented in Figure 2 to Figure 5. In Figure 2, it can be seen that there are several areas in quadrant I (high-high), meaning that the area has a high incidence of COVID-19 and is surrounded by areas with a high incidence of COVID-19 as well. Areas in quadrant I include Padang City, Padang Panjang City, and Bukittinggi City.

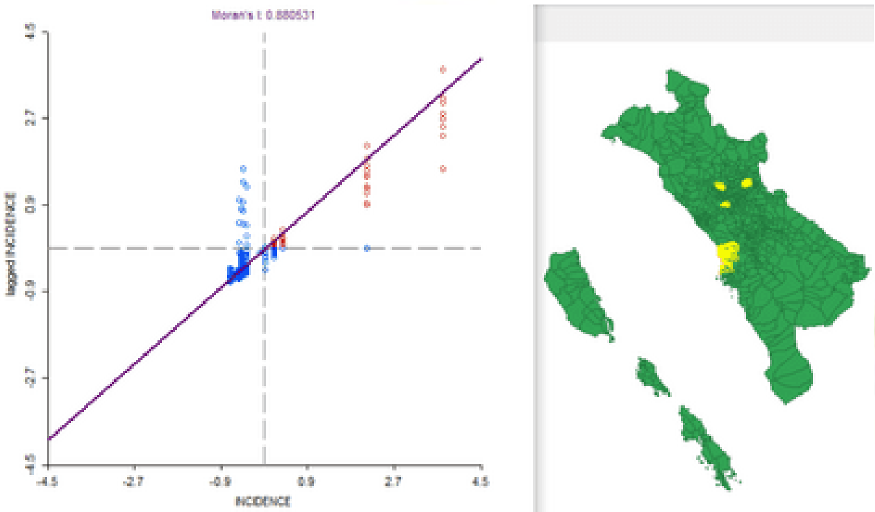


Figure 2. *Quadrant I Area (High-High)*

In Figure 3, it can be seen that there are several areas that are in quadrant II (Low-High), meaning that areas with low incidence are surrounded by areas with high values. On the map, it can be seen that the areas included in quadrant II are several sub-districts that are directly adjacent to Padang City, such as sub-districts in Padang Pariaman Regency and Solok Regency.

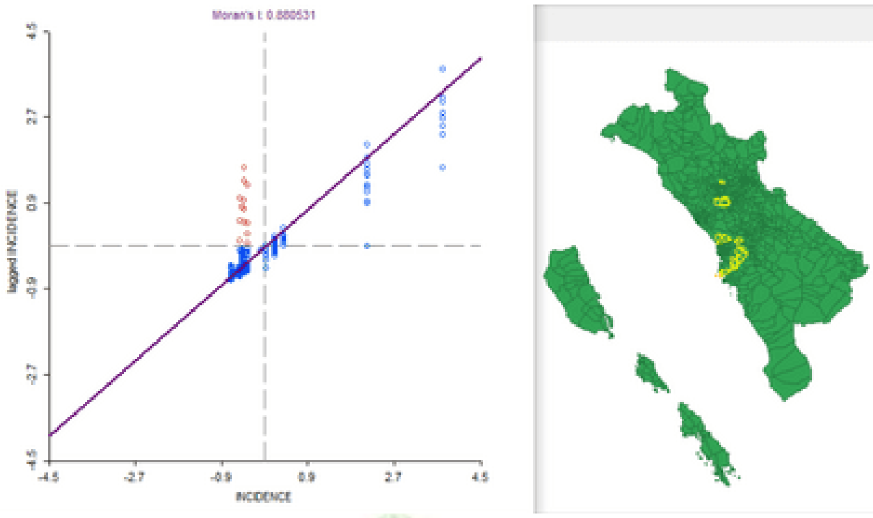


Figure 3. *Quadrant II (Low-High)*

Next, in Figure 4, it can be seen that many areas are in quadrant III (Low-Low), meaning that areas with low incidence are surrounded by areas that have low incidence. The map shows areas in Quadrant III, including Pasaman Regency, West Pasaman Regency, Agam Regency, Lima Puluh Kota Regency, Pesisir Selatan Regency, Solok Regency, Tanah Datar Regency, South Solok Regency, Sawahlunto Regency and Sijunjung Regency.

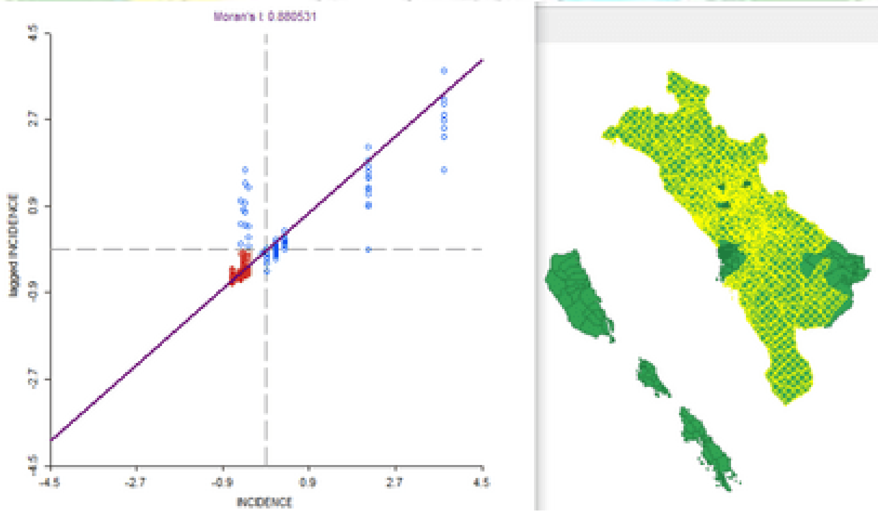


Figure 4. *Quadrant III (Low-Low)*

In Figure 5, it can be seen that there are several areas that are in Quadrant IV (High-Low), meaning that areas with high incidence are surrounded by areas with low incidence. On the map, it can be seen that the area in Quadrant IV is Dharmasraya District.

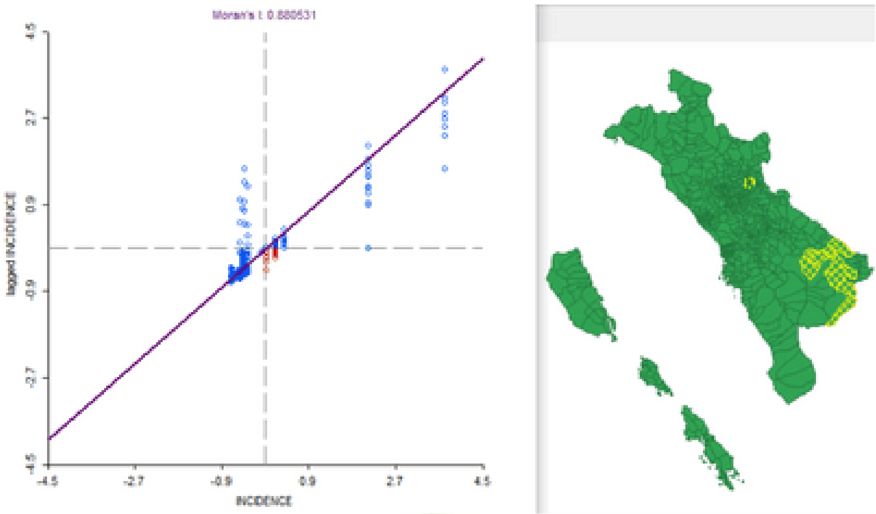


Figure 5. *Quadrant IV (High-Low)*

Global indices and local indices can be used to assess the tendency of spatial clustering (spatial autocorrelation). The global index used to determine the spatial relationship of disease spread/distribution is the Moran Index. Moran's index only represents global/general spatial autocorrelation and does not indicate the existence of spatial pattern information in a particular region. Thus, local indices need to be used to evaluate the presence of spatial clustering locally and describe the form of spatial relationships, namely using the Local indicator of spatial association (LISA) (Anselin, 2019; Anselin, 1995; Nakhapakorn & Jirakajohnkool, 2006).

Spatial relationships based on LISA values can be interpreted as follows (Dray, 2011; Salima & Bellefon, 2018; Saputro, 2017) :

a) Hot Spots, or High-high (H-H) areas, which indicate areas that have a high-high (H-H) spatial relationship with surrounding areas if they have a significant and equally high LISA value, meaning that areas with a high number of cases are close to areas with a high number of cases as well.

b) Outliers, or Low-high (L-H) areas, indicate areas that have a low-high (L-H) spatial relationship with the surrounding area if they have a significant LISA value and are lower than the surrounding area, meaning that areas with a low number of cases are adjacent to areas with a high number of cases.

c) Outliers, or high-low (H-L) areas, which indicate areas that have a high-low (H-L) spatial relationship with their surrounding areas if they have a significant and higher LISA value compared to their surroundings, meaning that areas with a high number of cases are adjacent to areas with a low number of cases.

d) Cold Spots, or low-low (L-L) areas, which indicate areas that have a low-low (L-L) spatial relationship with their surrounding areas if they have a significant LISA value and are equally low, meaning that areas with a low number of cases are adjacent to areas with a low number of cases.

The LISA value in each district/city in West Sumatra Province is used to see an overview of the mapping of the distribution of COVID-19 cases in West Sumatra which has a significant spatial influence. The LISA value can be used as an indicator in showing statistically meaningful spatial relationship groupings. This means that districts/cities with the same LISA value as the surrounding area and statistically significant show certain spatial relationships (high-high (H-H), low-low (L-L), high-low (H-L) and low-high (L-H)) using the LISA cluster map.

In Figure 6, identification with LISA values can show that High-High (H-H) spatial relationships occur in Padang City. The H-H relationship shows that areas with high LISA values are surrounded by areas with high LISA values as well. While the low-low (L-L) spatial relationship is a classification with the most members that occurs in West Pasaman Regency, Pasaman Regency, Payakumbuh City, Solok Regency, Padang Pariaman Regency, Pariaman City, Sawahlunto City, and Sijunjung Regency.

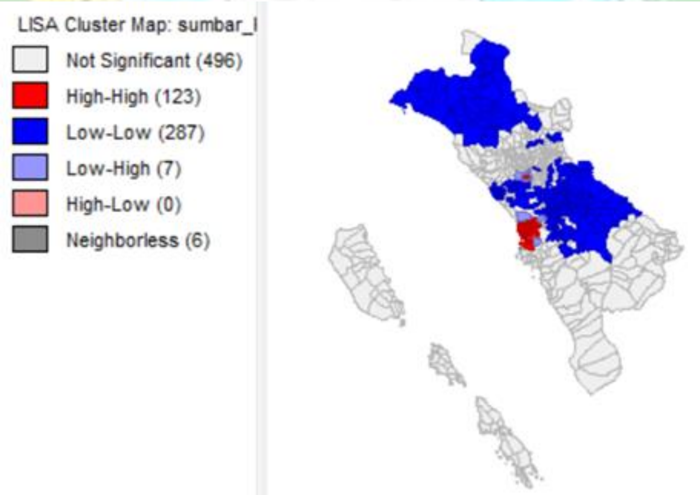


Figure 6. *Map of COVID-19 Distribution in West Sumatra Province in 2020*

The distribution pattern of COVID-19 in West Sumatra Province is seen from the comparison of the Moran index value with the $E[I]$ value, where the $E[I]$=-1n-1=-0.055. If the Moran index value is smaller than $E[I]$, then there is negative spatial autocorrelation, and vice versa, if the Moran Index value is greater than $E[I]$, then there is positive spatial autocorrelation (Dray, 2011). In Figure 1, it can be seen that the Moran index value of 0.8805

is greater than the value of E(I)= -0.055, so it can be concluded that there is positive spatial autocorrelation.

Spatial autocorrelation indicates that both high-high (H-H) areas or hotspots, and low-low (L-L) or cold spots have a statistically significant relationship with the spread of COVID-19 cases. In Figure 7, it can be seen that the majority of hotspots and cold spots regions have a $p \leq 0.01$ value and are shown in a darker green colour, while regions other than green have no statistically significant spatial relationship with the incidence of COVID-19 cases.

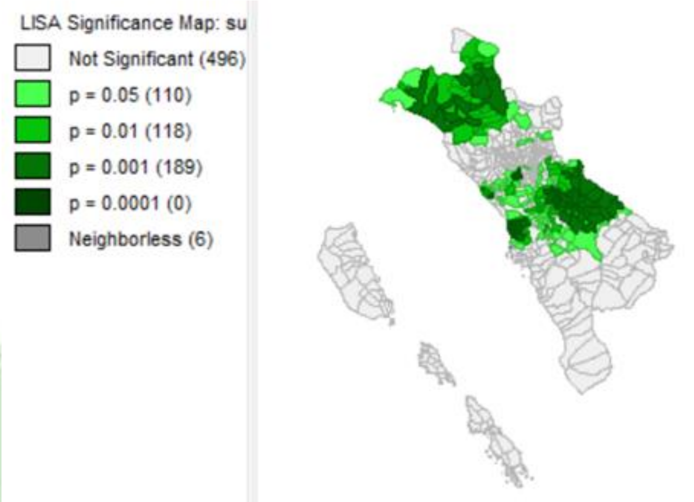


Figure 7. *Significance Map of the Spread of COVID-19 Cases in West Sumatra Province*

DISCUSSION

Padang City was identified as a hotspots area, meaning that in Padang City there is a pattern of COVID-19 spread associated with areas that also have a high incidence. Some sub-districts that reportedly received many COVID-19 case reports are East Padang Sub-district, Koto Tangah Sub-district, West Padang Sub-district, South Padang Sub-district, Lubuk Begalung Sub-district, and Kuranji Sub-district. Padang City is one of the main entrances to West Sumatra Province and can be accessed from land, sea and air transport routes, such as Teluk Bayur seaport and Minangkabau International Airport, so the risk of COVID-19 transmission from other provinces and countries is higher than other districts/cities. In addition, the attractiveness of West Sumatra Province as a tourist destination causes mobility in and out, potentially causing crowds by visitors from neighbouring provinces such as Riau, Jambi and North Sumatra. These results are in line with research conducted in Hubei Province, China, that the results of the spatial pattern of the Moran coefficient show spatial clusters reveal that high population concentrations are the cause of the outbreak of the Corona virus in the province (Yang, 2020; Isazadeh, 2021).

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Bukittinggi city and Padang Panjang City also detected as hot spots area, with high number of cases and smaller population than Padang city, which led to high incidence rates. These areas possibly received the most population from Padang city, because of people mobility among these districts, which known as culture city and one of the best tourism destinations in West Sumatera Province. The lack of maximum screening and supervision at the entrance is one of the potential possibilities of many imported cases entering, and then transmitting to the local population, resulting in local transmission. This can be seen in early April 2020, which is known that there are no restrictions on domestic and international flights at Minangkabau International Airport, when the Covid-19 case began to spread, many international tourists still came to West Sumatra Province.

The delay in the diagnosis stage also affects the speed of transmission and has an impact on the slow response to COVID-19. During the early days of the COVID-19 pandemic in Indonesia, suspicious samples could only be tested at the national-level laboratory under the Ministry of Health (Hidayani, 2020). This meant that it took days to send samples from the regions to the national-level laboratory and get results from the national-level laboratory. This makes it more likely for COVID-19 to spread because many suspects don't know what their exact status is. This is combined with the fact that West Sumatra Province won't have a large-scale policy in place by early June 2020 to limit the risk of COVID-19 cases spreading, such as restrictions on travel from within and outside the region, limits on activities outside the home, and strict supervision of the implementation of health protocols. As long as there are no restrictions, especially on people's travel, the risk of transmission in different areas will remain high.

One indicator that can be used is mobility data provided by Google (Mobility Report), which can help provide an overview of population movements, both at home, and in public facilities such as shopping centres, recreation centres, and offices. Mobility report data on 21 May 2020 shows that West Sumatra's population movement has increased again compared to data on 16 May 2020, despite the Large-Scale Social Restrictions (PSBB) policy that has been implemented (Google, 2020). The increase in population mobility especially occurred in shopping centres (grocery and pharmacy), an increase of 28%, retail and recreation centres (retail and recreation) increased by 19%, parks (parks) increased by 25%, and transit stations (transit stations) increased by 15%. Therefore, interventions that should be carried out in high incidence areas to reduce transmission and reduce the number of cases include lockdown, maximum screening, and rapid case management (Google, 2020).

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West Pasaman Regency, Pasaman Regency, Payakumbuh City, Solok Regency, Padang Pariaman Regency, Pariaman City, Sawahlunto City, and Sijunjung Regency are included in cold spots, which are areas with a low incidence of COVID-19 and surrounded by areas with a low incidence as well. Basically, districts/municipalities included in cold spots areas have the possibility of becoming hotspots, if at any time there is an increase in incidence in one area, and then transmitting to the surrounding area. An increase in incidence in the region can occur if the ongoing surveillance system is unable to detect changes in trends, increase in cases, and track the possibility of super spreaders, namely people infected with COVID-19 and without symptoms, then become carriers of COVID-19 transmission in the population.

Therefore, a good collaboration and coordination effort between local governments is needed in implementing efforts to control the spread of COVID-19. In this case, data sharing, especially related to surveillance, travel data or population mobility is needed as a basis for policy-making for local governments, in implementing evidence-based policies, so that programmes and activities carried out as a form of intervention become more focused and directed, as needed because they have been planned and studied according to actual conditions in the field.

CONCLUSIONS

The grouping of sub-districts in districts/cities indicated as hotspots and cold spots have a positive spatial autocorrelation so that there is a relationship between geographical location and the spread of COVID-19 cases in West Sumatra Province. Padang City is a hotspot area so effective measures are needed to reduce incidences, such as implementing regional quarantine, screening and rapid case management. As for cold spots that have a low incidence, they must continue to be monitored through strict surveillance to avoid case spikes. There is a need for coordination and collaboration between local governments and related sectors in the regions in the COVID-19 transmission control programme.

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